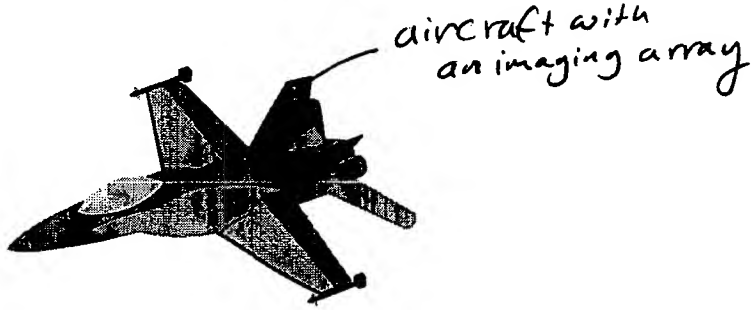
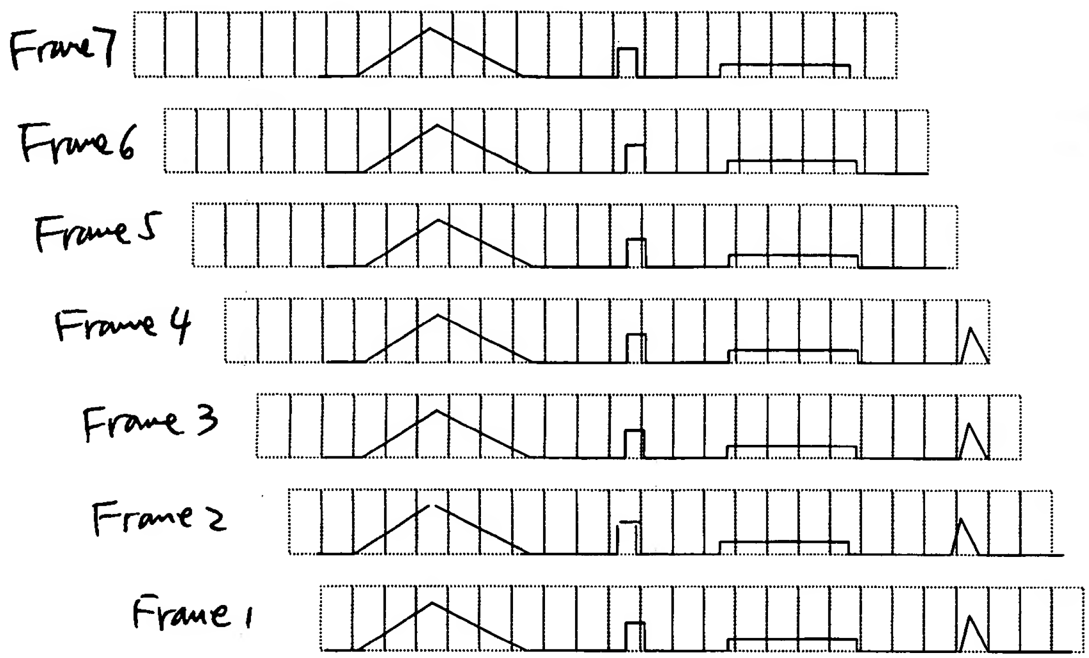
# FIG. 1A Time-Delayed Integration





Averaging of successive images (shifted by one-pixel) taken in sequence from a moving platform such as an airplane or satellite in order to improve the signal-to-noise ratio.

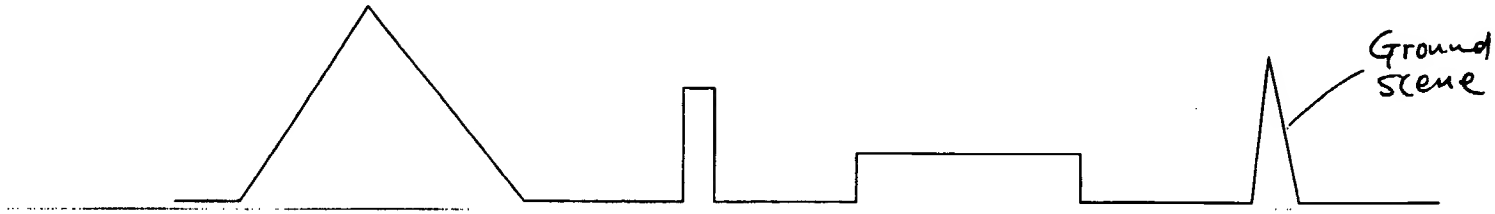
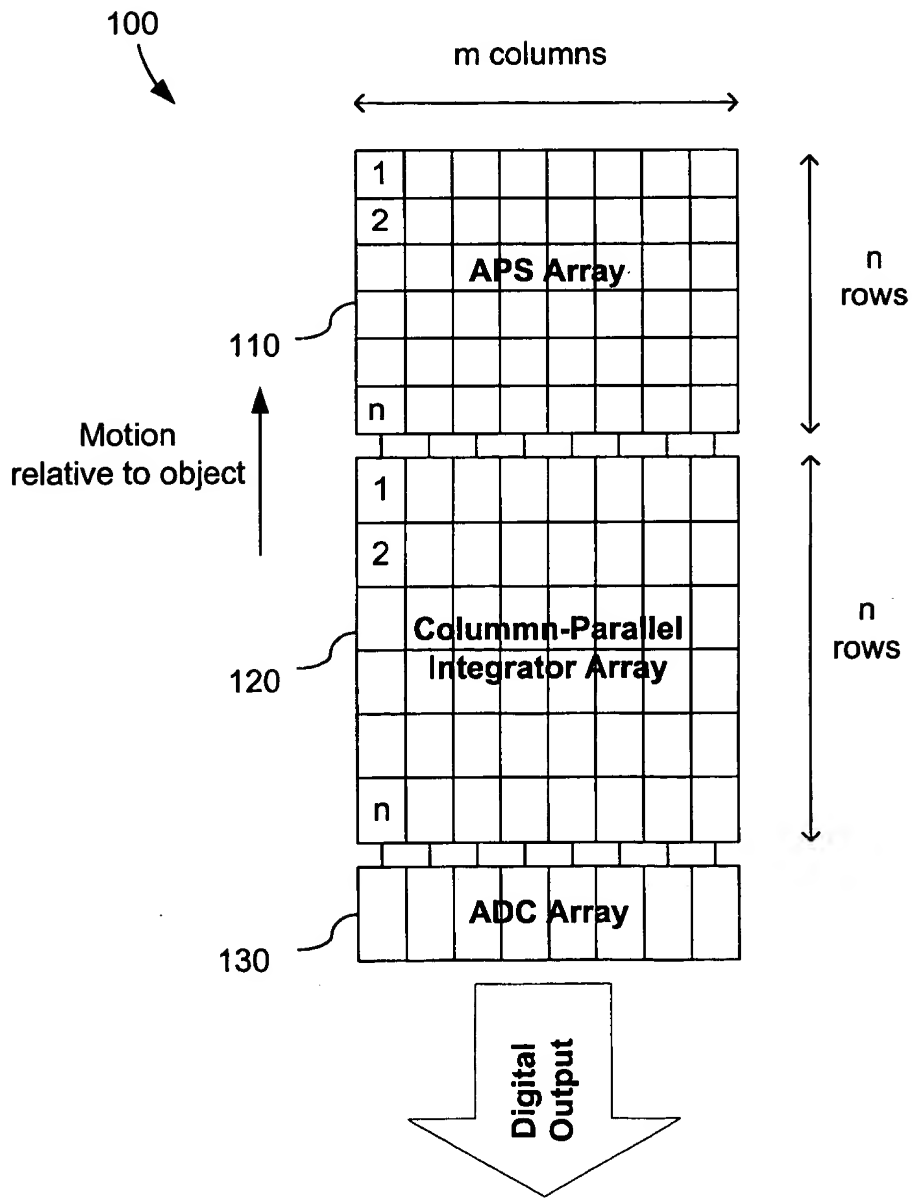


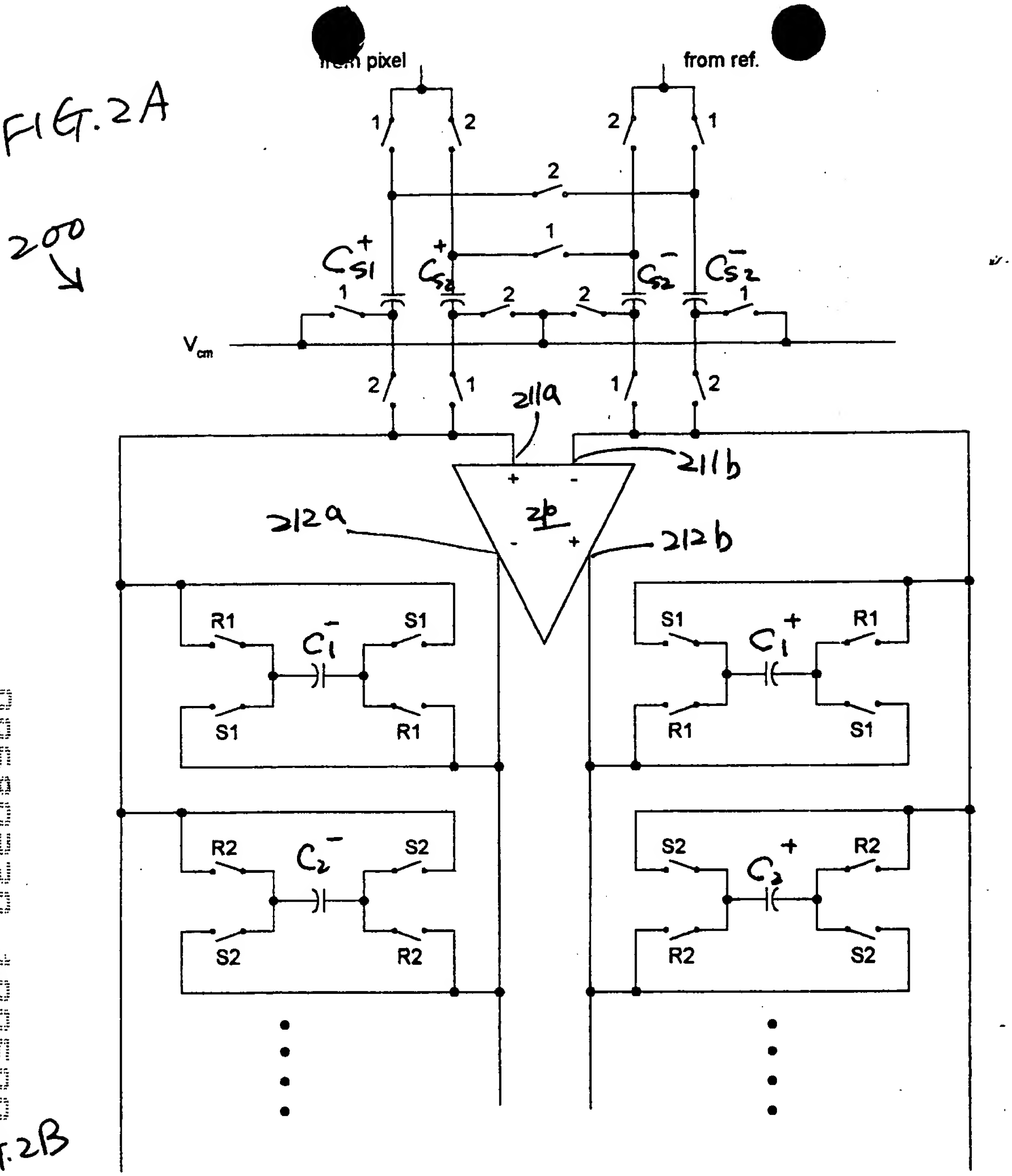
FIG. 1B


100
m columns
1
2
APS Array
n
n
rows
110
Motion
relative to object
1
2
Colummn-Parallel
Integrator Array
n
n
rows
120
ADC Array
130
Digital
Output

# FIG. 1C. Time-Delayed Integration: Clocking Operation

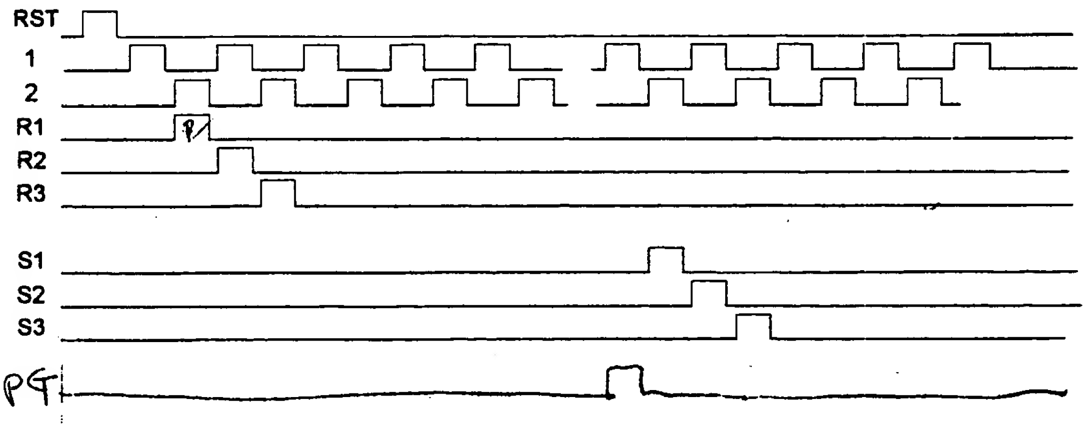
| First Frame | Second Frame | Third Frame |
|---|---|---|
| Pixel 1 → Integrator 1 | Pixel 2 → Integrator 1 | Pixel 3 → Integrator 1 |
| Pixel 2 → Integrator 2 | Pixel 3 → Integrator 2 | Pixel 4 → Integrator 2 |
| Pixel 3 → Integrator 3 | Pixel 4 → Integrator 3 | Pixel 5 → Integrator 3 |
| Pixel 4 → Integrator 4 | Pixel 5 → Integrator 4 | Pixel 6 → Integrator 4 |
| Pixel 5 → Integrator 5 | Pixel 6 → Integrator 5 | Pixel 7 → Integrator 5 |
| • | • | • |
| • | • | • |
| • | • | • |

FIG. 2A



from pixel
from ref.
200
1
2
2
1
2
1
$C_{S1}^{+}$
$C_{S2}^{+}$
$C_{S2}^{-}$
$C_{S2}^{-}$
1
2
2
1
$V_{cm}$
2
1
1
2
211a
211b
212a
20
212b
+
-
-
+
R1
$C_1^{-}$
S1
S1
R1
S1
$C_1^{+}$
R1
R1
S1
R2
$C_2^{-}$
S2
S2
R2
S2
$C_2^{+}$
R2
R2
S2

FIG. 2B



RST
1
2
R1
R2
R3
S1
S2
S3
PG

FIG. 3A

300

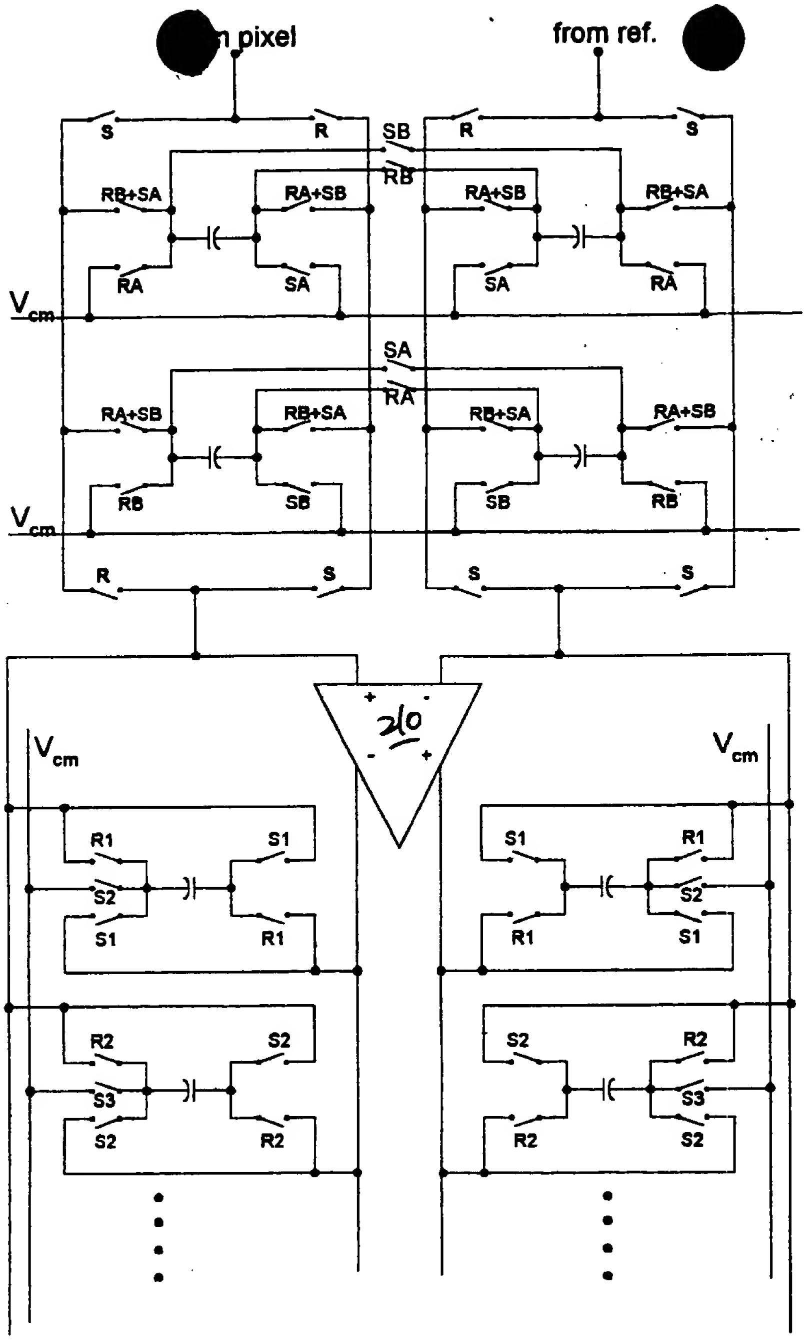


FIG. 3B

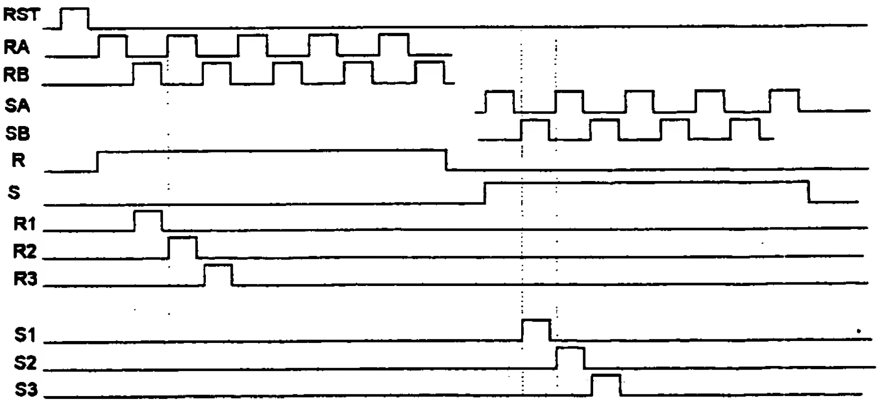


FIG. 4A

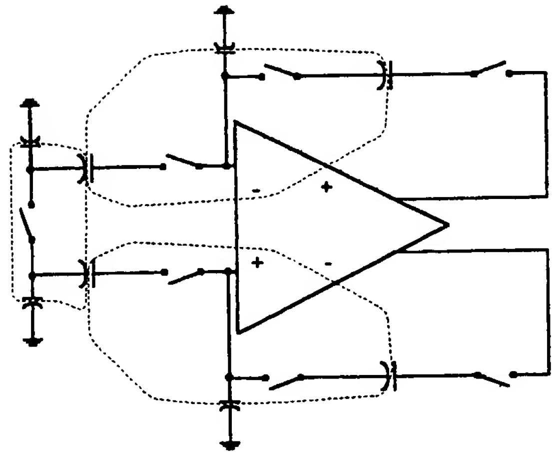


FIG. 4B

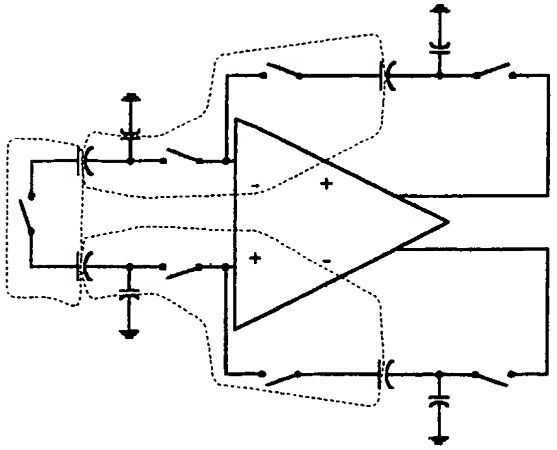


FIG. 5A

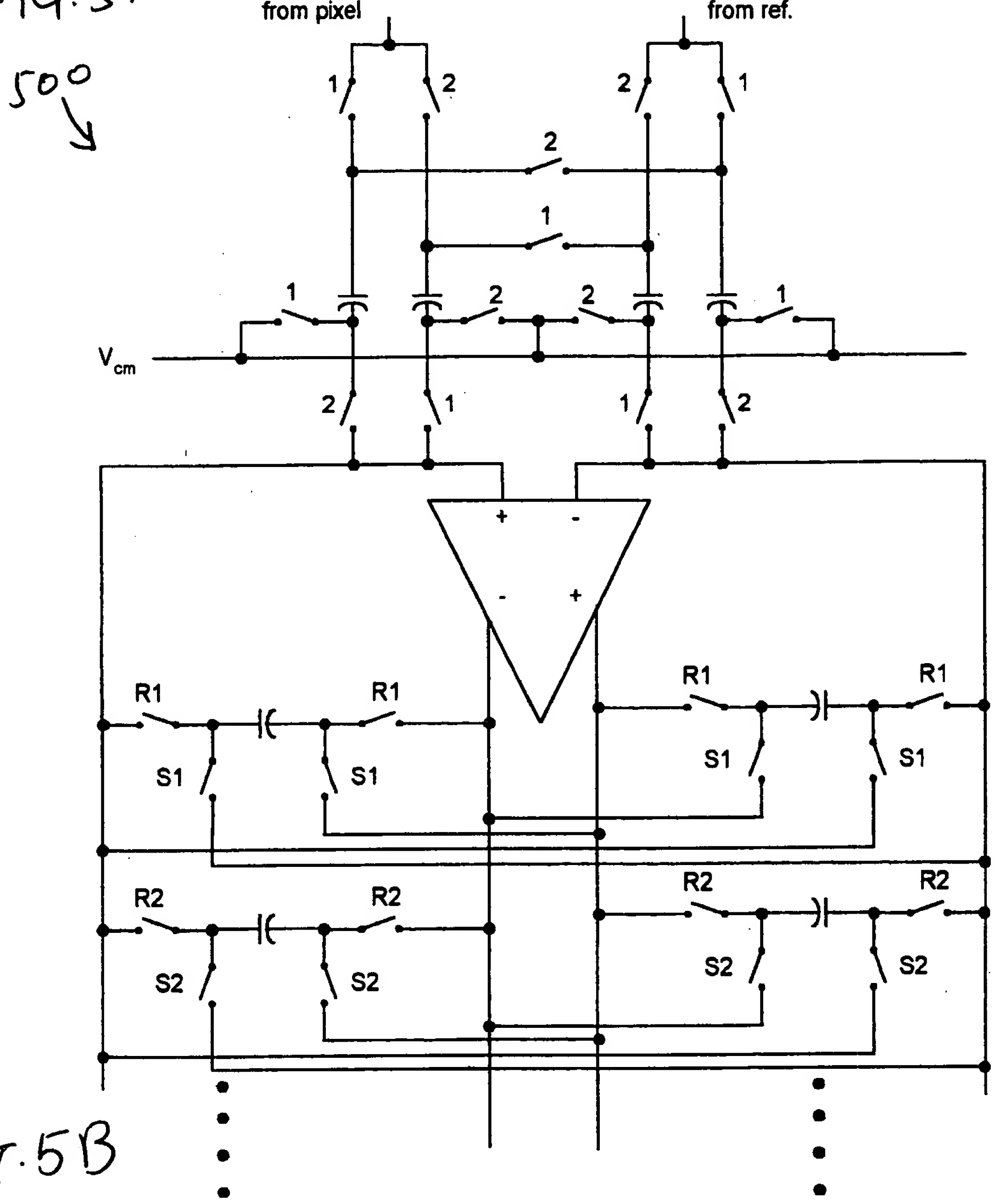

500
from pixel
from ref.
1
2
2
1
2
1
1
2
2
1
Vcm
2
1
1
2
+
-
-
+
R1
R1
S1
S1
R1
R1
S1
S1
R2
R2
S2
S2
R2
R2
S2
S2

FIG. 5B

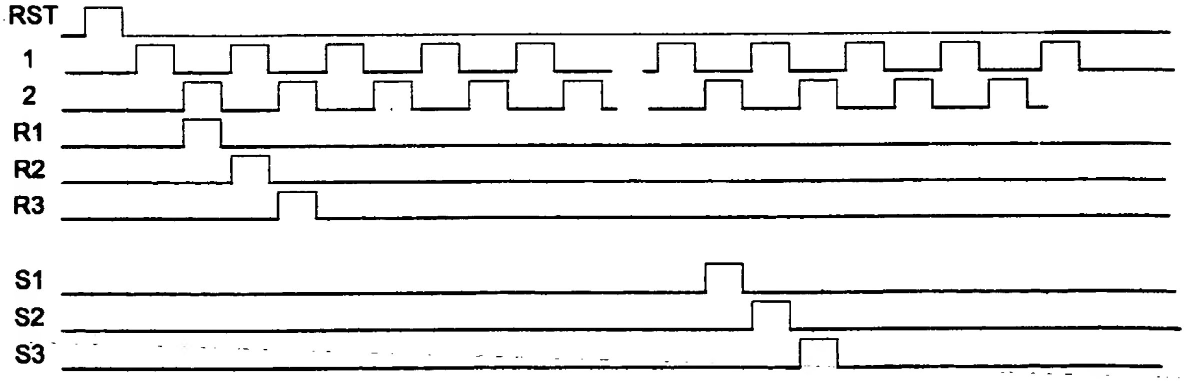
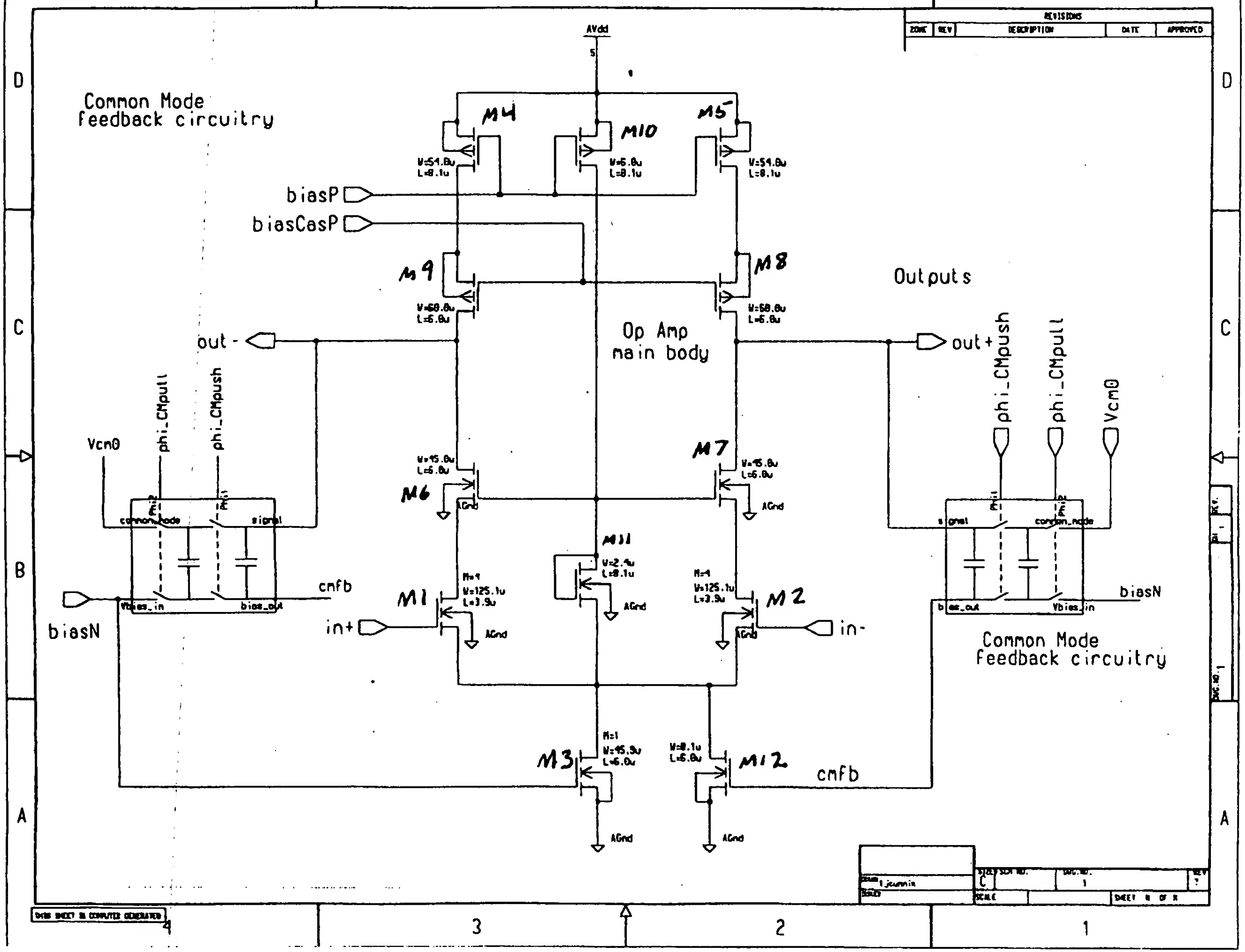

RST
1
2
R1
R2
R3
S1
S2
S3

FIG. 6



Common Mode
feedback circuitry
AVdd
5
M4
W=54.0u
L=8.1u
M10
W=6.0u
L=8.1u
M5
W=54.0u
L=8.1u
biasP
biasCasP
M9
W=60.0u
L=6.0u
M8
W=60.0u
L=6.0u
Outputs
out -
out +
Op Amp
main body
phi_CMpush
phi_CMpull
Vcm0
M7
W=45.0u
L=6.0u
M6
W=45.0u
L=6.0u
AGnd
M11
W=2.4u
L=8.1u
M1
M=4
W=125.1u
L=3.9u
M2
M=4
W=125.1u
L=3.9u
in+
in-
common_mode
signal
Vbias_in
bias_out
phi1
phi2
cmfb
biasN
M3
M=1
W=45.3u
L=6.0u
M12
W=8.1u
L=6.0u
Common Mode
feedback circuitry
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
SIZE
C
SCALE
DOC. NO.
1
SHEET
THIS SHEET IS COMPUTER GENERATED
D
C
B
A
4
3
2
1

FIG. 7A

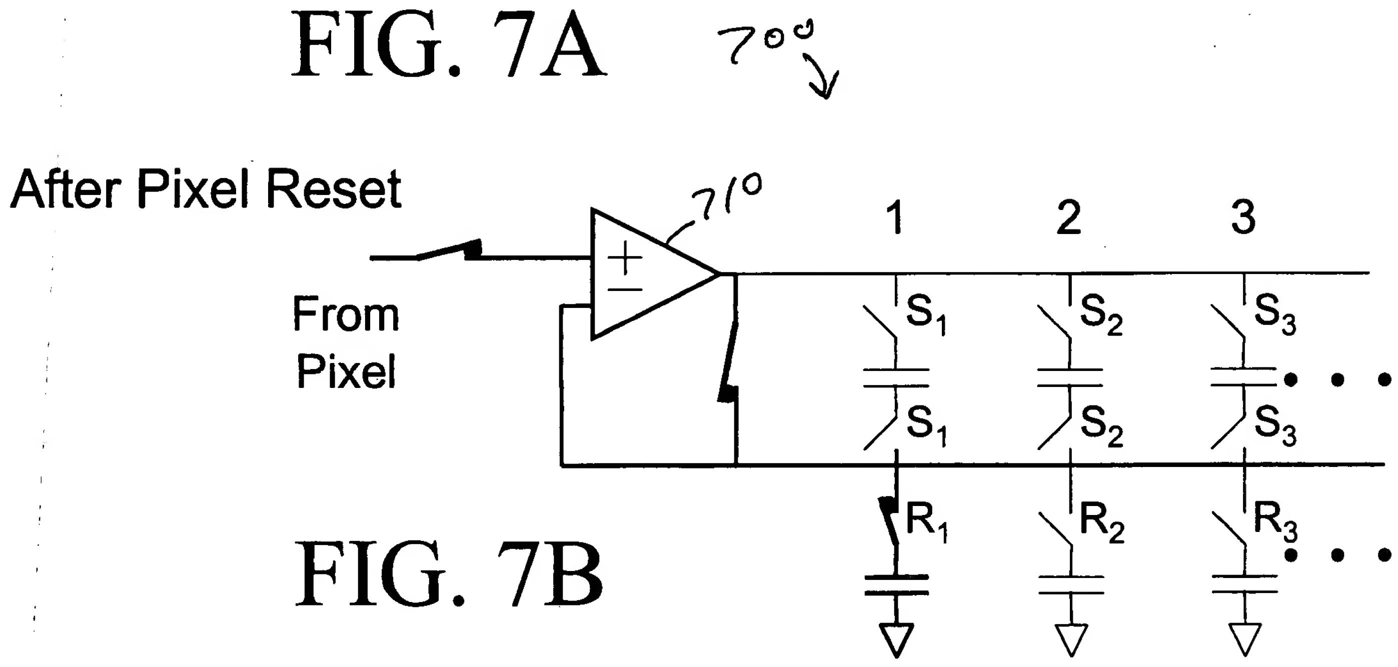
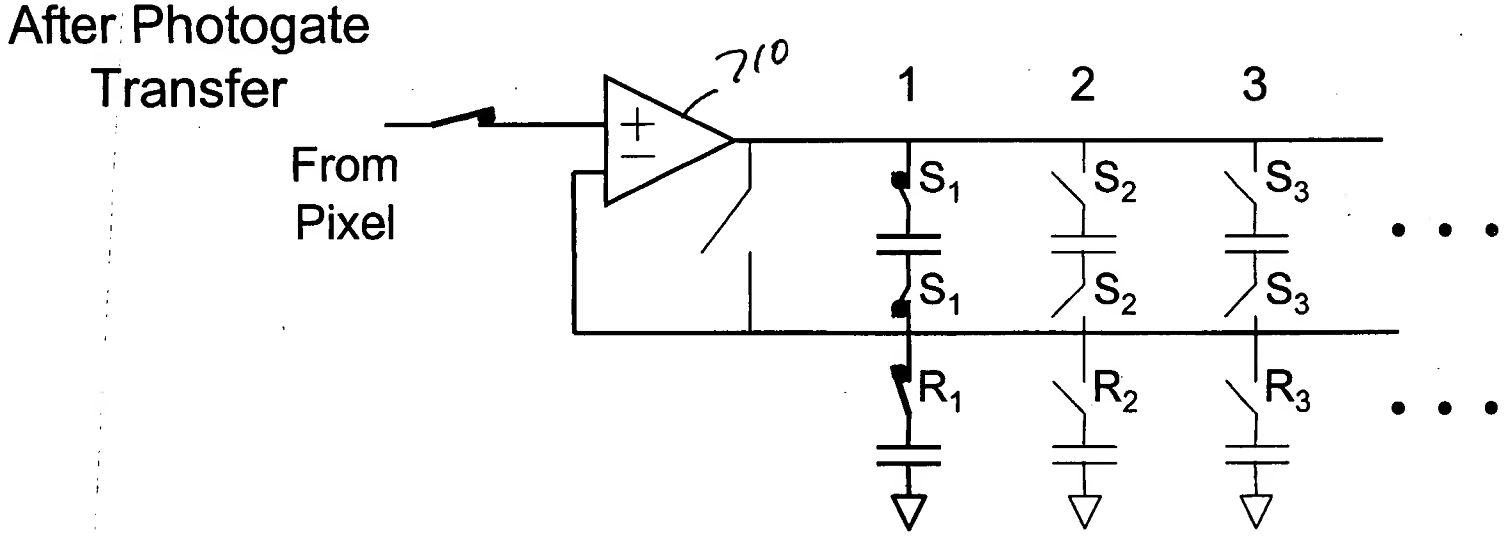

700
After Pixel Reset
From
Pixel
710
1
2
3
S1
S2
S3
S1
S2
S3
R1
R2
R3

FIG. 7B


After Photogate
Transfer
From
Pixel
710
1
2
3
S1
S2
S3
S1
S2
S3
R1
R2
R3

# FIG. 7C